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ABSTRACT

The Arizona Essential Skills states that development of problem-solving ability is the top priority of mathematics education. This study presents results of a survey of 744 K-8 teachers--631 females and 113 males--designed to investigate the current nature of mathematical problem-solving instruction in Arizona K-8 classrooms and the extent to which these practices reflect the National Council of Teachers of Mathematics' recommendations about problem-solving instruction. The results are organized by sections, based on groups of questions on the questionnaire. Each section includes a table of the mean responses by grade level for each item, a brief explanation of the instructional practice that was the focus of each item, and a brief summary of the section results. Section topics include: (1) instructional strategies; (2) sources of word problems; (3) teacher assessment of selected factors in problem solving; (4) usefulness of selected problem-solving strategies; and (5) statements about problem solving. The study concluded that the teachers responding to the survey were in alignment with the current recommendations for mathematics instruction and confident in their problem-solving ability and instruction. (MDH)

Arizona Elementary and Unified School Districts

Classroom Practices in Mathematical Problem Solving Instruction: Grades K-8

Survey Results

September 10, 1993

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Introduction

Problem solving has been the stated focus of elementary and middle level mathematics instruction since 1980 when the National Council of Teachers of Mathematics (NCTM) published their Agenda for Action. The NCTM renewed their commitment to problem solving instruction in the Curriculum and Evaluation Standards for School Mathematics ranking Problem Solving as the top priority of mathematics education for the 1990s (Standards, 1989). As a result of the NCTM's national influence, the Standards have become the benchmark for the development and evaluation of both mathematics curricula and mathematics instruction.

State Departments of Education have made strong statements outlining the future of mathematics education in their states using the Standards as a guide. The Arizona Essential Skills (1991) recognizes that the development of problem solving ability is the top priority of mathematics education and recommends instructional strategies to foster problem solving ability. Research articles (e.g., Kloosterman, 1992; Duren & Cherrington, 1992; Proudfit, 1992; Carey, 1991) and articles in teacher publications (e.g., Silverman, Winograd, and Strohauer, 1992; Kroll, Masingila & Mau, 1992; Maher & Martino, 1992) offer numerous recommendations for instructional techniques that promote problem solving ability.

Unfortunately, in spite of the continued focus on problem solving, American elementary and middle grade school children have been shown to be inadequate problem solvers. Teachers report that many students merely "give-up" when confronted with problem solving situations. This lack of achievement coupled with the national interest in problem solving and the plethora of information

available to assist teachers in problem solving instruction leads to several questions, two of which are central to this research project.

- What is the current nature of mathematical problem solving instruction in Arizona K-8 classrooms?

- To what extent do reported classroom practices in problem solving instruction reflect the recommendations of the National Council of Teachers of Mathematics and others?

Data Collection

Questionnaire development began with a review of the literature to identify recommendations about instructional strategies for developing student problem solving ability. These recommendations were the basis for writing 83, five point, Likert-type items that attempted to gauge teachers' frequency of use of these instructional strategies, teachers' perceptions of the usefulness of specific strategies for problem solving, teachers' confidence in using those strategies, and teachers' beliefs about specific recommendations for problem solving instruction. Additional items addressed sources of problems, time spent weekly on problem solving, demographic data about the teachers, teachers' self-assessment of their own problem solving ability, and teachers' assessment of their students' problem solving ability. The questionnaire was piloted with a small group (n=17) of elementary school teachers to evaluate its clarity and freedom from ambiguity. The questionnaire was revised based on the pilot administration. A copy of the questionnaire and cover letter distributed to teachers is included as an addendum to this report.

During the 1992-1993 school year 60 randomly selected elementary and unified school districts throughout Arizona were invited to participate in this survey study. Of those invited, 29 agreed to participate, one being the your school district. Copies of the questionnaire were sent to a contact person at each of the cooperating school districts. The contact person distributed the questionnaires to the participating schools. The completed questionnaires were collected and either picked up by, or mailed to, the researcher. Although gender, degree, and grade level of teaching assignment were included in the questionnaire, the names of the participants were not asked to retain anonymity.

Sample

The statewide sample consisted of 744 kindergarten through eighth grade teachers, 631 females and 113 males. Bachelor's degrees were the highest earned for 449 of the teachers, 292 had earned Master's degrees or higher. Seventy-three percent of the teachers responding taught in closed classrooms, 18% departmentalized, and three percent were teaching Special Education classes.

For data analysis the sample was subdivided into three groups by grade level: K-3 (primary grades), 4-6 (intermediate grades), and 7-8 (middle grades). Descriptions of the teachers by groups are contained in Table 1.

As reported in Table 1, about half of the sample was from the primary grades. Female teachers accounted for 85% of the entire sample, 96% at the K-3 level. Although the proportion of females decreased with increased grade level, female teachers still accounted for over half of the middle grade teachers. About 60% of the teachers surveyed reported having a Bachelor's degree. There was no apparent pattern involving highest degree earned and grade level. At the K-3 level about 90% of teachers were in closed classrooms. More

departmentalization was evident in the 4-6 grade (20%) and departmentalization is dominant (83%) in the 7-8 grade.

Table 1. Number and percentage of teachers by grade level, gender, degree earned, and classroom type.

Grade	N	Gender		Highest Degree		Type of Classroom		
		F	*M*	*BA/BS*	*MA/MS +*	*Closed*	*Deprtmt*	*SpEd.*
K-3	371 (50%)	356 (96%)	14 (4%)	239 (64%)	131 (35%)	335 (90%)	4 (1%)	10 (3%)
4-6	281 (38%)	225 (80%)	50 (18%)	152 (54%)	126 (45%)	206 (73%)	55 (20%)	9 (3%)
7-8	94 (13%)	50 (53%)	43 (46%)	58 (61%)	35 (37%)	7 (7%)	78 (83%)	2 (2%)
Total	746	631 (85%)	113 (15%)	449 (60%)	292 (39%)	548 (73%)	137 (18%)	21 (3%)

NOTE: Not all data sum to 100% due to missing responses on some of the surveys.

The sample was an experienced group of teachers with a mean of more than ten years of teaching experience (see Table 2) at all the grade levels. The mean time at current grade level indicates a stable teaching force. Teachers at both the K-3 and 4-6 levels reported teaching mathematics about five hours a week, about one hour per day. The mean hours per week at the 7-8 level were higher, probably due to departmentalization. The hours per week on mathematics problem solving at all three level accounted for 40 percent of total mathematics instructional time at both the K-3 and the 4-6 levels, decreasing to 30 percent at the 7-8 level.

At both the K-3 and the 4-6 levels, teachers averaged slightly more than one math inservice day per year. At the 7-8 level the average was 1.5 days. This no doubt is also a function of the departmentalization at the middle grades. It is

more likely that a person teaching more mathematics would be more likely to take an inservice on mathematics.

Table 2. Teachers' mean years of experience and time dedicated to mathematics instruction and inservice by grade level.

Grade	*Total Years in Teaching*	*Years at Current Grade Level*	*Hours /Week on Math*	*Hours /Week on Math Problem Solving*	*Inservice Days /Year on Mathematics*
K-3	12.1	6.1	4.7	1.9	1.2
4-6	12.1	5.2	5.0	2.0	1.1
7-8	11.8	6.6	11.6	3.5	1.5

Results

The remaining 83 items on the questionnaire required teachers to respond on Likert-type scales to a variety of statements about mathematical problem solving instruction.

This report will organize the results of the study into sections parallel to the sections of the original questionnaire. Each section will include:

- a table of the mean responses for each item from that section reported by grade level.
- a brief explanation of the instruction practice that was the focus of each individual item.
- a brief summary of the section results when appropriate.

SECTION 1

Items 11 through 16-Instructional Strategies

Teachers were asked to respond concerning their frequency of use of six recommended instructional strategies for problem solving instruction. Their choices were: 5-most of the time, 4-often, 3-sometimes, 2-not very often, and 1-not at all. The mean responses by grade level appear in Table 3. High means on these items indicate alignment with recommendations for problem solving instruction.

Table 3. Mean responses to items 11-16 by grade level.

		K-3	4-6	7-8
11. Students work in small groups or with a friend.		3.75	3.44	3.48
12. Students model the problem with manipulatives.		4.09	2.83	2.27
13. Students explain how they had solved a problem.		3.77	3.66	3.73
14. Teacher asks for different ways to solve the same problem.		3.52	3.44	3.76
15. Students are asked to defend their reasoning and answer.		3.28	3.46	3.94
16. Students make up their own word problems to share.		3.05	2.63	2.30

Item 11 Students work in small groups or with a friend.

Working in small groups or in pairs allows students the opportunity to verbalize their thoughts as they work through problems. Talking about problems allows students to clarify their own understandings, to compare their ideas with the ideas of others, and to prepare for presentations to the larger group. Teachers at all grade levels use small groups with the K-3 teachers grouping more often. Teachers' mean responses indicate a moderate level of alignment with recommendations for instruction.

Item 12 Students model the problem with manipulatives.

Modeling problems with manipulatives allows students to physically explore problem situations on the concrete level. The use of manipulatives also provides models that can aid in visualization of problem situations. Teachers at the K-3 levels use manipulatives often, however, the use of manipulatives decreases with grade level.

The decreased use of manipulatives at the upper grade levels is contrary to recommended methods for mathematics. This decreased use may be the result of viewing manipulatives as something for young children, reasoning that older children should rely more on paper and pencil. Many manipulatives are available for use with the intermediate and middle grades.

Item 13 Students explain how they had solved a problem.

Students need to explain in their own words how they solved a problem. The verbalization of thinking results in increased understanding. The explanations allow students who were unable to solve the problem see how others approached it. Children become aware that different students solve problems in different ways. The role of modeling problem solving is shared by the entire class, not assumed solely by the teacher. Teachers used this instructional strategy at all grade levels.

Item 14 Teacher asks for different ways to solve the same problem.

Teachers should encourage students to search for different ways to solve the same problem. Solving problems in different ways helps students to understand that there is not one "correct way" to solve a problem, but many possibilities. This practice also promotes discourse as the students explain their various methods. Teachers use this instructional strategy at all grade levels.

Item 15 Students are asked to defend their reasoning and answer.

Students need to be challenged to defend their thinking and solutions to problems. This strategy encourages discourse about mathematics and also helps children build self-confidence. Self-confidence nurtures self-reliance as children learn to trust in their own abilities in contrast to relying on the teacher to validate problem solutions. Teachers at all grade levels use this strategy sometimes to often with the frequency of use increasing with grade level.

Item 16 Students make up their own word problems to share.

Sources of good word problems are sometimes difficult to find. Having students write their own word problems provides problems for classroom use that can be more interesting than problems in commercially obtained materials. Additionally, writing clearly stated, solvable problems, gives students an insight into problem structure which enables them to become better problem solvers. Teachers reported a low level of use for this instructional strategy at all grade levels with the frequency of use decreasing with grade level.

Summary

With the exception of manipulatives used to model problems at the intermediate and middle grade levels and the practice of having students compose their own word problems, teachers appear to be in moderate alignment with these recommendations for problem solving instruction

SECTION 2

Items 17 through 20-Sources of Word Problems

Teachers were asked to respond concerning their perception of the usefulness of selected sources for word problems. Their choices were: 5-very useful, 4-useful, 3-about average, 2-not very useful, and 1-not at all useful.

Many school districts use a textbook series as a foundation for mathematics instruction. Textbook publishers have been under fire for using word problems that are viewed by some as being simplistic and unrealistic. Teachers rated textbooks as average to useful with a low rating at the K-3 level and higher ratings at the upper levels. The data in Table 4 indicate that at all grade levels the textbook was perceived as less useful than other sources with the exception of "other" at the 7-8 grade level.

Table 4. The perceived usefulness of sources for word problems by grade level.

Source	*K-3*	*4-6*	*7-8*
Textbooks	**2.79**	**3.46**	**3.45**
Teacher	**3.96**	**3.81**	**3.79**
Supplemental	**4.02**	**4.16**	**3.80**
Other	**3.98**	**3.95**	**3.25**

Teachers at the primary grade levels rated textbook usefulness as low and rely heavily on sources outside of their textbooks for word problems. Examples of the teacher supplied "Other" sources were: material from other subjects to work out real problems, student created problems, Math Their Way, videos, workbooks, and teaching store supplies.

SECTION 3

Items 21 through 27-Teacher Assessment of Selected Factors in Problem Solving

Teachers were asked to rate their own problem solving and their students' problem solving on a traditional 4 point grading scale (A=4, B=3, etc.). The means appear in Table 5.

Table 5. Teachers' assessments of self and students.

		K-3	4-6	7-8
21. Your own problem solving ability.		3.10	3.20	3.33
22. Your skill in teaching problem solving.		3.00	3.01	2.88
23. Your motivation to teach problem solving.		3.17	3.23	2.97
24. Your students' problem solving ability.		2.47	2.26	2.12
25. Your students' interest in problem solving.		2.62	2.15	1.97
26. Your students' effort in problem solving.		2.55	2.40	2.21
27. Your students' ability to discuss their problem solving work.		2.29	2.42	2.21

Note: The highest possible rating on this table is 4.

Many teachers at the K-8 level suffer from mathematics anxiety and lack self-confidence in teaching mathematics. This anxiety and lack of confidence influence teachers to shy away from areas of mathematics that are perceived as difficult, for example, problem solving. Teachers feel confident about mathematical problem solving instruction. They awarded themselves grades in the "B" range for problem solving ability, instruction, and motivation to teach problem solving.

As discussed earlier, many students are perceived as having low problem solving ability. Teachers awarded their students average grades in terms of ability to solve problems, interest in solving problems, effort in solving problems,

and ability to discuss their problem solving efforts with grades ranging from "C" to "C+". It seems natural that teachers would rate themselves somewhat higher than their students. The grades assigned to students for ability, motivation, and interest in problem solving tended to decrease with grade level.

SECTION 4

Item 28 through 48-Usefulness of Selected Problem Solving Strategies

Teachers were asked to respond on a five point scale (5= very useful, 4=useful, 3= uncertain, 2= not very useful, and 1= not at all useful) about the usefulness of specific problem solving strategies that appear in textbooks and other sources. The means for all responses appear in Table 6. Specific problem solving strategies are included in current recommendations for mathematics instruction. These strategies provide students with techniques helpful in working toward the solutions to problems.. They also may provide students with an approach to solving word problems. Teachers rated these types of strategies as useful with most means around 4. The usefulness of some of the strategies appeared to a function of grade level. For example, Act It Out is a strategy seen as more useful by K-3 teachers, whereas, Guess Check Revise is seen as more useful in the upper grades. The use of specific strategies is congruent with current recommendations and a widely used approach to mathematical problem solving.

"Other" strategies supplied by teachers for items 48 and 69 included: count how many, picture the situation in your mind, look for key words, and think of a number sentence.

Table 6. Mean ratings of the usefulness of specific problem solving strategies.

		K-3	4-6	7-8
28. Act it out.		4.38	3.96	3.45
29. Check reasonableness of answer.		3.94	4.27	4.36
30. Choose an operation.		4.04	4.19	4.33
31. Draw a diagram.		4.29	4.59	4.36
32. Draw a picture.		4.60	4.53	4.21
33. Estimate.		4.08	4.12	4.18
34. Find the facts.		4.14	4.55	4.42
35. Find the question.		4.19	4.56	4.42
36. Guess check revise.		3.61	3.85	3.91
37. Listen carefully.		4.44	4.41	4.42
38. Look for a pattern.		4.58	4.45	4.12
39. Make a graph.		4.27	4.26	3.76
40. Make a physical model.		4.17	3.93	3.73
41. Make a table or a chart.		4.06	4.21	3.91
42. Solve a simpler problem.		4.06	4.21	4.03
43. Sort and classify.		4.38	4.15	3.85
44. Use a model.		4.37	4.25	4.03
45. Use manipulative.		4.75	4.40	3.94
46. Work backwards.		3.46	3.78	3.85
47. Write a number sentence.		3.93	3.95	3.78
48. Other _____		3.71	4.09	3.00

Items 49 through 69-Confidence in Using Selected Problem Solving Strategies

Teachers were asked to respond on a five point scale (5= very confident, 4=confident, 3= uncertain, 2= not very confident, and 1= not at all confident) about their confidence in using specific problem solving strategies. Confidence was high with most means around 4. Mean confidence ratings appear in Table 7. As with the usefulness ratings, the some of the confidence ratings varied as a function of grade level. For example, teachers' confidence in using manipulatives decreased with grade level as did perceived usefulness of manipulatives.

Summary

Teachers rated the set of strategies similarly in terms of usefulness and confidence. Teachers believe in the usefulness of these strategies and are confident in using them in their classrooms.

Table 7. Mean ratings of confidence in using selected problem solving strategies.

		K-3	4-6	7-8
49. Act it out.		4.28	3.87	3.61
50. Check reasonableness of answer.		4.14	4.34	4.61
51. Choose an operation.		4.41	4.40	4.45
52. Draw a diagram.		4.42	4.49	4.36
53. Draw a picture.		4.54	4.43	4.27
54. Estimate.		4.30	4.34	4.58
55. Find the facts.		4.44	4.55	4.55
56. Find the question.		4.45	4.51	4.64
57. Guess check revise.		4.01	4.06	4.15
58. Listen carefully.		4.55	4.38	4.52
59. Look for a pattern.		4.53	4.35	4.45
60. Make a graph.		4.47	4.24	4.42
61. Make a physical model.		4.13	3.80	4.00
62. Make a table or a chart.		4.33	4.32	4.30
63. Solve a simpler problem.		4.31	4.48	4.58
64. Sort and classify.		4.53	4.26	4.15
65. Use a model.		4.39	4.20	4.12
66. Use manipulative.		4.68	4.12	4.06
67. Work backwards.		3.94	3.83	4.27
68. Write a number sentence.		4.29	4.28	4.19
69. Other _____		3.79	4.11	4.14

SECTION 5

Items 70 through 93-Statements About Problem Solving

Teachers were asked about their agreement with statements about problem solving (5=strongly agree, 4= agree, 3= undecided, 2= disagree, and 1= strongly disagree). Some of the statements were negatively phrased, that is, disagreement with the statement indicates alignment with recommendations for problem solving, some were positively phrased, and others were neutral statements intended to collect additional information.

Negatively Phrased Statements

Table 8. Mean responses to negatively phrased statements.

		K-3	4-6	7-8
70. It is better to tell or show students how to solve problems than to let them discover how on their own.		2.12	2.29	2.69
71. Teachers must be very good at problem solving before they can help their students become efficient problem solvers.		2.70	3.07	3.76
72. I feel a sense of insecurity when attempting to conduct problem solving instruction.		2.14	2.11	2.00
74. Teachers should tell students the best way to solve each type of problem.		2.15	2.14	2.73
76. Getting the correct answer should be the main focus of problem solving in elementary school.		2.15	2.17	2.30
78. Students need to be given the right answer to all of the problems they work.		2.63	2.81	3.18
79. Hearing different ways to solve the same problem confuses children.		1.99	2.00	1.94
80. Students need to know the "key word" approach to problem solving.		3.34	3.66	3.88
81. I enjoy teaching most other subjects more than mathematics.		2.11	2.07	2.27
82. I would like to try new ideas but I am not confident that they will work.		2.48	2.64	2.44
83. The textbook I use in my classroom supplies all that I need to know about teaching problem solving.		1.75	1.76	1.97
91. It is more important for children to compute efficiently, than to solve word problems.		2.10	2.16	2.30

Note: Low means on this table indicate alignment with recommendations.

Item 70 It is better to tell or show students how to solve problems than to let them discover how on their own.

Telling students how to solve problems does not help them to become better problem solvers. They need to apply their own powers of reasoning to formulate solutions. Telling students how to solve a problem diminishes problem solving to following a set of directions. Responses indicate moderate compliance to recommendations.

Item 71 Teachers must be very good at problem solving before they can help their students become efficient problem solvers.

Teachers do not necessarily have to be good problem solvers to help their students to be. Even teachers who feel they are not good problem solvers can help students to develop problem solving ability through the frequent explorations of a wide variety of problems. Teachers tended to agree with this statement with agreement increasing with grade level. Fortunately, teachers feel that they are good problem solvers (item 21).

Item 72 I feel a sense of insecurity when attempting to conduct problem solving instruction.

If teachers feel insecure about their problem solving instruction, they may be inclined to omit it from their schedules. Teachers tended to disagree with this statement. Their disagreement is congruent with both their high self-assessment as problem solving instructors (item 22) and their confidence in using specific problem solving strategies (items 49-69).

Item 74 Teachers should tell students the best way to solve each type of problem.

Telling students the best way to solve a type problem limits student thinking and arbitrarily labels one method as the best, implying that other methods are of less value. This strategy develops student dependence on the teachers' directions that limits problem solving. Teachers disagreed with this statement and align with recommendations.

Item 76 Getting the correct answer should be the main focus of problem solving in elementary school.

The process of solving a problem, finding alternative solution methods, being able to defend a problem solution, and the correct use of problem solving strategies should be the focus of problem solving instruction, not the "answer to the problem". Teachers at all grade levels disagreed with this statement. That disagreement is congruent with the recommendations.

Item 78 Students need to be given the right answer to all of the problems they work.

Problem solving instruction should include the development of students' self-confidence in their reasoning abilities. After a group of students have solved a problem and discussed their methods, they should know whether or not they have the right answer. Relying on some authority (e.g., the teacher) to give the correct answer is not necessary if students have confidence in their own cognitive abilities. Teachers were undecided about this statement.

Item 79 Hearing different ways to solve the same problem confuses children.

Students need to understand that problems can be solved more than one way. Discussing multiple solution methods allows students to see connections in mathematics. Teachers disagreed with this statement.

Item 80 Students need to know the "key word" approach to problem solving.

The key word approach suggests that recognizing a keyword in a problem will enable the student to pick an operation and solve the problem. This approach does not emphasis the importance of understanding the problem situation. The keyword approach is most helpful when the direct application of operations on the numbers given in the problem will result in the correct answer. Teachers' mild agreement, increasing at the upper levels, with this statement is contrary to the recommendations.

Item 81 I enjoy teaching most other subjects more than mathematics.

If teachers feel that teaching math is an enjoyable experience, their students are more likely to enjoy math. Teachers' disagreement with this statement indicate that they enjoy teaching mathematics relative to other subjects.

Item 82 I would like to try new ideas but I am not confident that they will work.

Mathematics instruction has changed considerably over the last 10 years. If experienced teachers are not willing to try new ideas and approaches, for any reason, they will not be able to implement the current recommendations. Teachers' disagreement with this item indicate a willingness to try new ideas.

Item 83 The textbook I use in my classroom supplies all that I need to know about teaching problem solving.

The type of word problems presented in textbooks has been criticized as being artificial and too succinct. Although word problems from texts could be one part of problem solving instruction, there is a need for more complex and involved problem situations. Textbooks also supply teacher recommendations for problem solving instruction. Teachers' fairly strong disagreement with this statement is congruent with their high ratings of other sources for problem solving materials (items 17-20).

Item 91 It is more important for children to compute efficiently, than to solve word problems.

Although a basic understanding of computation is necessary for estimation and mental math, the calculator has freed us from the necessity of doing complex computation with paper and pencil. Applying mathematics to solve problems is the more worthwhile and more difficult task. Teachers' disagreement with the statement implies alignment with the recommendations.

Summary

Teachers were in alignment with recommendations on all the negatively phrased statements with two exceptions.

- Item 78 means were all close to three. This indicates a focus on the answer to problems and a reliance on the teacher or some other authority to supply the correct answers. This is contrary to recommendations.
- Item 80 means were middle to high threes. The "key word approach" is one strategy that should be de-emphasized in the classroom, the emphasis should be on understanding problem situations.

Positively Phrased Statements

Table 9. Mean responses to positively phrased statements.

	K-3	4-6	7-8
73. The best way to become a good problem solver is to solve a lot of problems.	3.74	3.57	3.73
75. Problem solving should be the major emphasis of mathematics instruction.	3.72	3.56	3.48
77. I feel very confident when I am discussing word problem in my class.	3.95	3.97	3.94
87. Children can develop their word problem solving skills by working together in small groups.	4.05	4.12	3.79
88. Calculators are useful in solving word problems.	3.55	3.53	3.85
89. I always allow my students to use calculators when they are solving word problems.	2.24	2.40	3.06
92. My students solve word problems every day.	3.34	3.20	3.55

Note: High means on this table indicate alignment with the recommendations.

Item 73 The best way to become a good problem solver is to solve a lot of problems.

Although instruction can focus on specific aspects of the problem solving process, the experience of solving problems and discussing solution methods is necessary to develop problem solving ability. Teachers' agreement with this statement indicates alignment.

Item 75 Problem solving should be the major emphasis of mathematics instruction.

The focus of mathematics for the 1990s is problem solving. Teachers' agreement with this statement indicates alignment with the recommendation.

Item 77 I feel very confident when I am discussing word problem in my class.

Teachers need to talk to their students and have students talk to them about word problems. Without confidence in doing this, it will tend not to get done. Teachers' agreement with this statement indicates alignment and is congruent with their self-ratings on problem solving (items 21-23).

Item 87 Children can develop their word problem solving skills by working together in small groups.

Working in small groups allows children the opportunity to verbalize their methods, assist each other on more difficult problems, and be exposed to other points of view. Teachers' agreement with this item is congruent to recommendations. It should be noted that the agreement was rated higher than the frequency of using small groups (item 11).

Item 88 Calculators are useful in solving word problems.

Calculators can free students from the low level task of calculation and allow them to focus more on problem solving. Teachers' agreement with this statement indicate alignment with recommendations.

Item 89 I always allow my students to use calculators when they are solving word problems.

Calculators should be available for use at all times. Teachers' disagreement with this statement indicated a lack of alignment with the recommendations. It should be noted that even though teachers somewhat agreed that calculators were useful, their frequency of use was rated lower.

Item 92 My students solve word problems every day.

Students need to solve many and varied problems daily. Teachers at the K-3 level tended to disagree with the level of agreement increasing with grade level. Agreement with this statement is congruent to the recommendations.

Summary

In general, teachers agreed with the positively phrased statements with the exception of item 89. Teachers disagreed with the statement that they always let their students use calculators when they are solving word problems. This disagreement was in spite of the fact that teachers also saw calculators as useful in solving word problems (item 88). The recommendation of the NCTM if that calculators be available for student use at all times.

Neutral Statements

Table 10. Mean responses to neutrally phrased statements.

		K-3	4-6	7-8
84.	Students need a step by step plan to follow in order to solve problems.	2.97	3.11	3.38
85.	Students don't like to solve word problems because they are too much work or too difficult.	2.69	3.14	3.09
86.	Most of my students easily solve the word problems supplied by the textbook.	2.85	2.73	2.38
90.	I believe that this survey is collecting valuable information about practices in problem solving instruction	3.48	3.48	3.24
93.	I need advice about how to teach problem solving in my classroom.	3.08	3.26	2.85

Item 84 Students need a step by step plan to follow in order to solve problems.

Step by step plans are recommended in many textbooks as well as in the literature about problem solving. There is disagreement as to the desired specificity of problem solving plans and their general applications to all types of problems. Teachers mildly agree that the plans are necessary.

Item 85 Students don't like to solve word problems because they are too much work or too difficult.

Solving word problems requires thinking and is more difficult than following a set of directions or replicating a previously demonstrated process. As a result, some students are not motivated to solve problems. Teachers at the K-3 level moderately disagreed, at the 4-8 levels they moderately agreed.

Item 86 Most of my students easily solve the word problems supplied by the textbook.

Although textbook problems have been characterized as being simplistic, many student still have difficulty solving them. Teachers disagreed that the textbook problems were easy for their students.

Item 90 I believe that this survey is collecting valuable information about practices in problem solving instruction.

Teachers moderately agreed that the survey was collecting useful information.

Item 93 I need advice about how to teach problem solving in my classroom.

Teachers mildly agreed that they need help in problem solving instruction.

Overall Summary and Recommendations

The teachers responding to this survey study represent an experienced group who are confident in their problem solving ability and instruction. They actively seek out sources for problem solving materials other than their textbooks. They believe that problem solving strategies are useful and they are confident using them in the classroom.

Their responses indicated that they are, as a group, in alignment with the current recommendations for mathematics instruction as outlined by the NCTM and others. They should be commended.

Possible exceptions to that general alignment are:

- **Item 12** The low frequency of using manipulatives to model problems at the intermediate and middle grade levels is of concern. Responses to item 45 indicated that teachers perceive manipulatives as a useful problem solving strategy and responses to item 66 indicated that teachers feel confident in using manipulatives. However, the frequency of use is low. A closer look at the use of manipulatives at the intermediate and middle grades should be conducted to validate this condition. If manipulatives are not being used steps should be taken to determine the causes and rectify the situation.

- **Item 89** The disagreement with this item indicated that teachers often do not allow their students to use calculators when they are solving word problems. However, teachers agreed that calculators were useful in solving word problems (item 88). As with the use of manipulatives, further investigation should

be conducted to validate the low frequency of calculator use. If validated, factors inhibiting calculator use should be identified and compensated for.

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Addendum

Teacher Survey on Problem Solving

Arizona State University West

Education and Human Services
P.O. Box 37100
Phoenix, Arizona 85069-7100
602/543-6300
FAX: 602/543-6350

October, 1992

Dear Teacher,

I am an assistant professor at ASU West in the Education Unit. The attached survey is intended to gather information concerning your beliefs about and practices in the teaching of mathematical word problem solving. I am requesting your voluntary participation in this project. Return of the questionnaire will be considered as your consent to participate.

The completion of the survey should take approximately 15 minutes of your time. Most of the questions require that you circle the appropriate response. A few items require that you fill in a blank with a number or some other information. Each section includes additional instructions concerning your responses. When it is completed, please return it to the building principal.

There are many approaches to word problem solving instruction which are well suited for the elementary grades. This survey will not be used as an evaluation of your problem solving instruction but only to gather data concerning the reality of the classroom. Please respond as honestly and openly as possible. We are interested in what you actually do and what you actually believe, not in your perception of what you should do and should believe.

The results of this survey will not be reported in any manner which could reflect negatively on you, your school, or your school district. All data will be reported anonymously.

Thank you for your consideration and time. If you have any questions or concerns please call or write.

Sincerely,

Ron Zambo

Ron Zambo
ASU West, Education
P. O. Box 37100
Phoenix, AX 85059-7100
602-543-6365

TEACHER SURVEY ON PROBLEM SOLVING INSTRUCTION

GENERAL INFORMATION

Instructions. (Circle your choice.)

1. CURRENT GRADE LEVEL K 1 2 3 4 5 6 7 8

2. PREVIOUS GRADE LEVEL K 1 2 3 4 5 6 7 8 none

3. HIGHEST DEGREE EARNED. BA/BS MA/MS Ed. Spec Ph.D.

4. GENDER Female Male

5. TYPE OF CLASSROOM Closed Special Education Closed
Departmentalized Special Education Resource Room

Instructions. (Fill in the blanks with numbers.)

6. About how many inservice days a year do you devote to math? _____

7. Years at current grade level _____

8. Total years of teaching experience _____

9. Total hours of instructional time per week teaching mathematics _____

10. Total hours of instructional time per week teaching mathematical problem solving _____

INSTRUCTIONAL STRATEGIES

Instructions. (For each strategy, circle the response that best describes the frequency of use in your classroom.)

		most of the time	often	sometimes	not very often	not at all
11.	Students work in small groups or with a friend.	4	3	2	1	0
12.	Students model the problem with manipulatives.	4	3	2	1	0
13.	Students explain how they had solved a problem.	4	3	2	1	0
14.	Teacher asks for different ways to solve the same problem.	4	3	2	1	0
15.	Students are asked to defend their reasoning and answer.	4	3	2	1	0
16.	Students make up their own word problems to share.	4	3	2	1	0

SOURCES OF WORD PROBLEMS

Instructions. (Circle the number representing the usefulness of each of the following sources of mathematics word problems.)

5=very useful 4=useful 3=about average 2=not very useful 1=not at all useful

17. Textbooks 5 4 3 2 1
18. Teacher written 5 4 3 2 1
19. Supplemental Materials 5 4 3 2 1
20. Other _____ 5 4 3 2 1

TEACHER ASSESSMENT OF SELECTED FACTORS

Instructions. (Circle the letter grade you would assign to each of the following.)

21.	Your own problem solving ability.	A	B	C	D	F
22.	Your skill in teaching problem solving.	A	B	C	D	F
23.	Your motivation to teach problem solving.	A	B	C	D	F
24.	Your students' problem solving ability.	A	B	C	D	F
25.	Your students' interest in problem solving.	A	B	C	D	F
26.	Your students' effort in problem solving.	A	B	C	D	F
27.	Your students' ability to discuss their problem solving work.	A	B	C	D	F

USEFULNESS OF SELECTED PROBLEM SOLVING STRATEGIES

Instructions. (For each strategy, rate its usefulness in classroom instruction.)

		Very useful	Useful	Uncertain	Not very useful	Not at all useful
28.	Act it out.	5	4	3	2	1
29.	Check reasonableness of answer.	5	4	3	2	1
30.	Choose an operation.	5	4	3	2	1
31.	Draw a diagram.	5	4	3	2	1
32.	Draw a picture.	5	4	3	2	1
33.	Estimate.	5	4	3	2	1
34.	Find the facts.	5	4	3	2	1
35.	Find the question.	5	4	3	2	1
36.	Guess check revise.	5	4	3	2	1
37.	Listen carefully.	5	4	3	2	1
38.	Look for a pattern.	5	4	3	2	1
39.	Make a graph.	5	4	3	2	1
40.	Make a physical model.	5	4	3	2	1
41.	Make a table or a chart.	5	4	3	2	1
42.	Solve a simpler problem.	5	4	3	2	1
43.	Sort and classify.	5	4	3	2	1
44.	Use a model.	5	4	3	2	1
45.	Use manipulative.	5	4	3	2	1
46.	Work backwards.	5	4	3	2	1
47.	Write a number sentence.	5	4	3	2	1
48.	Other _____	5	4	3	2	1

CONFIDENCE IN USING SELECTED PROBLEM SOLVING STRATEGIES

Instructions. (For each strategy, rate your confidence level in using that strategy.)

		Very Confident	Confident	Uncertain	Not very confident	Not at all confident
49.	Act it out.	5	4	3	2	1
50.	Check reasonableness of answer.	5	4	3	2	1
51.	Choose an operation.	5	4	3	2	1
52.	Draw a diagram.	5	4	3	2	1
53.	Draw a picture.	5	4	3	2	1
54.	Estimate.	5	4	3	2	1
55.	Find the facts.	5	4	3	2	1
56.	Find the question.	5	4	3	2	1
57.	Guess check revise.	5	4	3	2	1
58.	Listen carefully.	5	4	3	2	1
59.	Look for a pattern.	5	4	3	2	1
60.	Make a graph.	5	4	3	2	1
61.	Make a physical model.	5	4	3	2	1
62.	Make a table or a chart.	5	4	3	2	1
63.	Solve a simpler problem.	5	4	3	2	1
64.	Sort and classify.	5	4	3	2	1
65.	Use a model.	5	4	3	2	1
66.	Use manipulative.	5	4	3	2	1
67.	Work backwards.	5	4	3	2	1
68.	Write a number sentence.	5	4	3	2	1
69.	Other _____	5	4	3	2	1

QUESTIONS ABOUT PROBLEM SOLVING

Instructions. (Circle the response that reflects your agreement with the following statements.)

		Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
70.	It is better to tell or show students how to solve problems than to let them discover how on their own.	SA	A	U	D	SD
71.	Teachers must be very good at problem solving before they can help their students become efficient problem solvers.	SA	A	U	D	SD
72.	I feel a sense of insecurity when attempting to conduct problem solving instruction.	SA	A	U	D	SD
73.	The best way to become a good problem solver is to solve a lot of problems.	SA	A	U	D	SD
74.	Teachers should tell students the best way to solve each type of problem.	SA	A	U	D	SD
75.	Problem solving should be the major emphasis of mathematics instruction.	SA	A	U	D	SD
76.	Getting the correct answer should be the main focus of problem solving in elementary school.	SA	A	U	D	SD
77.	I feel very confident when I am discussing word problem in my class.	SA	A	U	D	SD
78.	Students need to be given the right answer to all of the problems they work.	SA	A	U	D	SD
79.	Hearing different ways to solve the same problem confuses children.	SA	A	U	D	SD
80.	Students need to know the "key word" approach to problem solving.	SA	A	U	D	SD

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
81. I enjoy teaching most other subjects more than mathematics.	SA	A	U	D	SD
82. I would like to try new ideas but I am not confident that they will work.	SA	A	U	D	SD
83. The textbook I use in my classroom supplies all that I need to know about teaching problem solving.	SA	A	U	D	SD
84. Students need a step by step plan to follow in order to solve problems.	SA	A	U	D	SD
85. Students don't like to solve word problems because they are too much work or too difficult.	SA	A	U	D	SD
86. Most of my students easily solve the word problems supplied by the textbook.	SA	A	U	D	SD
87. Children can develop their word problem solving skills by working together in small groups.	SA	A	U	D	SD
88. Calculators are useful in solving word problems.	SA	A	U	D	SD
89. I always allow my students to use calculators when they are solving word problems.	SA	A	U	D	SD
90. I believe that this survey is collecting valuable information about practices in problem solving instruction	SA	A	U	D	SD
91. It is more important for children to compute efficiently, than to solve word problems.	SA	A	U	D	SD
92. My students solve word problems every day.	SA	A	U	D	SD
93. I need advice about how to teach problem solving in my classroom.	SA	A	U	D	SD

PROBLEM SOLVING INSTRUCTIONAL METHODS

Briefly describe the way in which problem solving instruction is typically conducted in your classroom. What do you do first? Second? Etc.?

Do you believe that you adequately include problem solving in your instruction?

If not, what are the obstacles that prevent you from including sufficient problem solving instruction?